REMARKS

Claims 1-3 and 8-26 remain in the application.

All remaining claims require the formation of at least part of the boron carbide layer over an anodized aluminum layer. This recitation corresponds generally to Claim 6, now incorporated into Claim 1, and base Claim 13. Applicants reserve the right to pursue the subject matter of unamended Claim 1 in a divisional application.

The Examiner has rejected Claims 6 and 13, as well as Claim 5, under 35 USC §103(a) as being obvious over JP 363203098A in view of Kramer et al. (US Patent 5,271,967) and further in view of the technical article of Srihari Ponnekanti et al. (hereafter Ponnekanti). The citation to JP 363202098A is apparently the reference number for the JPO English translation. The reference for the underlying Kokai is JP 63-203098A. This reference will hereafter be referred to as JP'098. (The same problem applies to the other cited but not applied Japanese reference.) For the Examiner's convenience, full translations of the two new Japanese references are enclosed.

This rejection is traversed. JP'098 discloses a speaker diaphragm in which plasma thermal spraying is used to coat a layer 2 of boron carbide on an aluminum frame plate 1. Thereafter, the assembly is sintered and the aluminum frame plate is converted to aluminum oxide (alumina), which is intertwined with the boron carbide. The prior art section discusses frame plates formed by coating ceramics such as alumina on an aluminum or other metallic frame plate. It is noted that alumina is closely related chemically to anodized aluminum. Importantly, JP'098 teaches against coating boron carbide on alumina. Instead, JP'098 teaches coating boron carbide on metallic aluminum and thereafter converting it to it's oxide form, alumina. Hence, there is a strong inference in JP'098 that boron carbide should not be coated on anodized aluminum, which has a surface chemistry very similar to alumina.

Kramer teaches thermal spraying a metal alloy onto cylinder walls surfaces of an aluminum engine block that have been cleaned and roughened with a high pressure water jet (col. 2, lines 42-59). The metal alloy is formed in a wire for use in the plasma gun. For example, the alloy is an aluminum bronze. Kramer does not suggest the use of boron carbide. Indeed, he is

promoting the use of wear resistant coating in engine cylinder walls. Boron carbide is very hard and tough material. There is no suggestion in the applied art that boron carbide can be substituted for Kramer's bronze aluminum as a wear resistant coating. Further, it is not clear that Kramer's thermal coating method as opposed to the plasma spraying technique of JP098 is even appropriate for the very high temperatures of boron carbide, and boron carbide is not well known in the wire form needed in his spraying apparatus. Further, the teaching of the advantages of surface roughness for bonding aluminum bronze to aluminum is not readily extended to such a technique for bonding boron carbide to aluminum.

However, most importantly and as now being specifically claimed, Kramer fails to teach coating his wear-resistant layer over anodized aluminum. In fact, he clearly teaches against such an anodization layer. First, he uses a high pressure water jet both to clean and to pit the aluminum surface. Such a process is likely to remove any anodization that may be present, and further is not a process used to produce an anodized aluminum surface. Secondly, Kramer's interfacial metallurgy is between aluminum and his metallic aluminum bronze. These two metallic materials are likely to bond together as long as they are not separated by barriers such as an anodization of the claims.

For the anodization layer, the Examiner relies upon Ponnekanti, and Ponnekanti does disclose the use of an anodized aluminum parts for use in a fluorine plasma environment. Ponnekanti describes several anodization failure mechanisms and possible remedies involving magnesium doping of the aluminum and aluminum crystallography. Nowhere does Ponnekanti suggest that the performance of his anodization can be improved by the use of another barrier material.

The applied art thus fails to suggest any advantage for coating boron carbide over an anodized aluminum layer. The applied art further fails to suggest a bilayer barrier over aluminum. JP'098 converts all of its aluminum to alumina after deposition of the boron carbide. Kramer fails to teach that boron carbide can be used as a wear resistant coating. Ponnekanti seems resigned to using only the anodization as a protective surface layer. No art has been

applied suggesting that Ponnekanti's anodized surface can be improved by a further layer of any material and in particular by a layer of boron carbide. The boron carbide layer of JP'098 is not used as a protection of the speaker diaphragm but as an intertwined support for it.

The Examiner attempts to justify the boron carbide coating in the other two references by the statement in JP'098 that boron carbide does not decompose at high temperatures. However, this well known fact is irrelevant to the other two references. Kramer's aluminum block would melt at temperatures above about 700°C so the boron carbide very high melting point of nearly 2450°C is irrelevant. Engine blocks simply aren't subjected to such high temperatures, and indeed the real purpose of the Kramer invention is to coat bronze aluminum on the cylinder wall without melting or deforming the aluminum block. Similarly, Ponnekanti's aluminum part is used in a plasma cleaning reactor. Temperatures in such reactors are typically relatively low, a few hundred degrees; their problem is the fluorine plasma. In any case, any temperature approaching the melting point of boron carbide destroys any cleaning reactor contmeplated by Ponnekanti. Only JP'098 considers a high temperature necessary and that is for its thermal conversion of aluminum to alumina. Accordingly, no art teaches applying a boron carbide coating on Ponnekanti's anodized aluminum.

The Examiner has rejected Claims 9-12 and 14-23 under 35 USC §103(a) as being obvious over JP'098 in view of Kramer and further in view of the technical article to J. Linke et al. (hereafter Linke) and Ponnekanti. These claims are dependent upon claims in allowable form and should therefore also be allowable.

Further, Claim 17 requires removing a portion of the anodization. The Examiner apparently relies upon Ponnekanti's teaching that a portion of the anodization is cracked while presumably other portions remained attached. However, such cracks are failure mechanisms occurring after use in Ponnekanti's plasma reactor. Surely, Ponnekanti cannot be read to suggest any advantage for cracking his anodization prior to its being coated with boron nitride and prior to use in his plasma reactor. Once a part has failed, the applied art is silent on further fabrication processing. No reasonable artisan reading Ponnekanti would be tempted to coat a cracked

anodization layer with another protective layer. Linke is not relevant to anodized aluminum surfaces, especially partially anodized ones. Accordingly, Claim 17 is additionally allowable. Further dependent claims have been added emphasizing the subject matter of Claim 17.

In view of the above amendments and remarks, reconsideration and allowance of all claims are respectfully requested. If the Examiner believes that a telephone interview would be helpful, he is invited to contact the undersigned attorney at the listed telephone number, which is on California time.

Respectfully submitted,

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Date: 8 Nov, 2001

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OIPE
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Serial No. 09/489,356

Version with markings to show changes made

1. (Already Amended) A method of coating boron carbide on an aluminum-based substrate, comprising the steps of:

roughening a surface of a substrate to a value of surface finish R_a of at least 2.5µm, wherein said substrate is composed of an aluminum-based material selected from the group consisting of substantially pure aluminum and aluminum alloys including at least 90 wt% elemental aluminum;

anodizing said substrate to form an anodization layer; and

depositing [forming] a boron carbide layer upon said anodization layer [surface].

2. (Amended) The method of Claim 1, wherein said depositing [forming] step comprises thermal spraying to form said boron carbide layer upon said surface.

3. (Amended) The method of Claim 1, wherein said depositing [forming] step comprises chemical vapor deposition.

Please cancel Claims 4, 5 and 6.

Please add the following new claims:

19 ~~24~~. (New) The structure of Claim 1, wherein said roughening step is performed before said anodizing step.

29 ~~25~~. (New) The structure of Claim 1, further comprising removing said anodization layer from only a first portion and not from a second portion of said surface of said substrate, wherein said boron carbide layer is deposited on both said first and second portions after said removing

step.

30 ~~26.~~ (New) The process of Claim 17, wherein said boron carbide layer is deposited over said first and second portions.

Japanese Kokai Patent Application No. Hei 8[1996]-176782

JAPANESE PATENT OFFICE
PATENT JOURNAL (A)
KOKAI PATENT APPLICATION NO. HEI 8[1996]-176782

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No. of Claims:	3 (Total of 5 pages; OL)
Examination Request:	Not filed

ROLL FOR TRANSPORTING HIGH-TEMPERATURE STEEL MATERIALS

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[There are no amendments to this patent.]

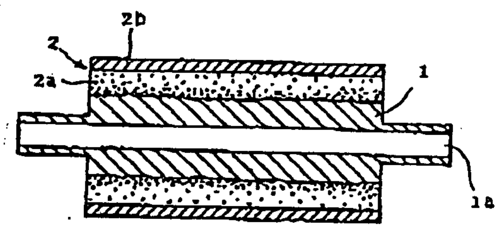
Abstract

Constitution

A foundation layer made of a heat resistant thermally sprayed alloy layer is formed on the roughened surface on the outer periphery of the roll base of a roll for transporting high-temperature steel materials. A thermally sprayed coating layer made of a powder mixture consisting of cermet powder and resin powder is formed on the foundation layer.

Effect

Since a good heat insulating property can be obtained at relatively high temperature, poor rotation caused by bending of the core of the roll can be prevented. Also, since the roll has machinability, no build-up will occur so that the service life of the roll can be prolonged. In addition, since the service life of the roll is extended, the maintenance period can also be prolonged, and the operation efficiency of the equipment can be improved.



Claims

1. A roll for transporting high-temperature steel materials characterized by the following facts: the roll has a thermally sprayed coating layer on the outer periphery of the roll;

a roughened surface is formed on the outer periphery of a roll base, and a foundation layer made of a heat resistant thermally sprayed alloy layer is formed on the roughened surface; a thermally sprayed mixture coating layer comprising cermet powder and resin powder is formed on the foundation layer.

2. The roll described in Claim 1 characterized by the fact that the content of the resin powder in the powder mixture of the cermet and resin is in the range of 15-30 wt%.

3. The roll described in Claim 1 or 2 characterized by the fact that the cermet powder is a mixture with excellent machinability containing 4-10 wt% BN and at least one metal selected from Ni, Co, Cr, Fe, and Al or their alloys as the remainder.

Detailed explanation of the invention

[0001]

Industrial application field

The present invention pertains to a transporting roll that is arranged in a heat treatment furnace for high-temperature steel material in which stainless steel plates, etc., are treated at high temperature. The purpose of the present invention is to improve the heat insulating property

while maintaining the build-up resistance so as to realize stable operation over a long period of time.

[0002]

Prior art

A hearth roll for a heat treatment furnace (referred to as transporting roll hereinafter) that is used to transport high-temperature stainless steel plates, etc., on a heat treatment line must have no adverse effects on the surface quality of the materials to be transported (referred to as transported material hereinafter). Therefore, a heat-resistant material is usually coated on the roll surface.

[0003]

However, since the transported material is softened on a transporting roll that is installed in the second half of the heating zone or the soaking zone of a heat treatment furnace with the temperature of the transported material treating atmosphere exceeding 1200°C, even a small change on the roll surface will affect the transported material and decrease its quality.

[0004]

As far as the transporting roll itself is concerned, since the roll is used in a high-temperature atmosphere, the main body (base) of the roll is usually cooled with water internally. Consequently, it is necessary to coat a heat-insulating material to prevent a drop in the temperature of the transported material on the roll surface that acts as a through plate surface for the transported material. The heat insulation coating material used for this purpose must not damage the transported material. Asbestos, silica/alumina fibers, etc., have been used. Japanese Kokai Patent Application Nos. Hei 1[1989]-290712, Hei 1[1989]-301818, etc., disclose a type of transporting roll for a roller hearth heating furnace, which is formed by means of compression molding after a heat resistant sheet part punched into a doughnut shape is inserted into an iron core [sic].

[0005]

The aforementioned well-known coated roll has the following problems. In a method that uses a heat-resistant and heat-insulating sheet, a large amount of labor and time are needed to fit the sheet on the roll. Also, according to the results of using the coated roll in an actual heat treatment furnace, the asbestos layer or inorganic fiber layer that acts as the coating part deteriorates and hardens significantly. As a result, the sheet falls off after a short period of time and becomes useless, while the operation cannot be stopped. In addition, scales generated on the

surface of the transported material are attached to the roll surface. The attached scales damage the material transported later. That is, the problem known as build-up will occur.

[0006]

In order to alleviate build-up, instead of using a conventional structure having a laminated sheet material mainly composed of inorganic fibers, Japanese Kokai Patent Application No. Hei 4[1992]-99813 disclosed a technology that thermally sprays and coats cermet with excellent machinability. However, since the thermally sprayed coating layer of this type of roll has a poor heat insulating property, even when cooled with water internally, the core is still deformed to cause poor rotation with damage to the transported material. Also, a drop in the temperature of the transported material (the transported material becomes about 1200°C) cannot be avoided. Since asbestos has a heat conductivity as low as 0.00037 [cal/cm·s·°C], the surface temperature of the core can be 50°C or lower. The thermally sprayed coating layer, however, has a heat conductivity as high as 0.3 [cal/cm·s·°C], and the surface temperature of the core rises up to about 1000°C. As a result, the aforementioned problems occur.

[0007]

Problems to be solved by the invention

The present invention proposes a surface structure for a roll that can solve the aforementioned problems. In particular, the present invention proposes a roll for transporting high-temperature steel material and with an excellent heat insulating property, machinability, and heat resistance.

[0008]

Means to solve the problems

In order to realize the aforementioned objective, the present invention provides a roll for transporting high-temperature steel product characterized by the following facts: the roll has a thermally sprayed coating layer on the outer periphery of the roll; a roughened surface is formed on the outer periphery of the roll base, and a foundation layer made of a heat resistant thermally sprayed alloy layer is formed on the roughened surface; a thermally sprayed mixture coating layer comprising cermet powder and resin powder is formed on the foundation layer. In the present invention, it is preferred that the content of the resin powder in the powder mixture of the cermet and resin be in the range of 15-30%. Also, it is preferred that the cermet powder be a mixture with excellent machinability containing 4-10 wt% BN and at least one metal selected from Ni, Co, Cr, Fe, and Al or their alloys as the remainder.

[0009]

Operation of the invention

In the following, the present invention will be explained in detailed with reference to figures. Figure 1 shows the configuration of the roll for transporting high-temperature steel material disclosed in the present invention. (1) represents a base that constitutes the main body of the roll having a flow path (1a) for cooling water at the core. (2) represents a heat-resistant/heat-insulating thermally sprayed film layer formed on the roughed surface of base (1). Said thermally sprayed coating layer (2) comprises a Co-Ni-Cr-Al-Y type heat-resistant thermally sprayed alloy layer (2a), which is formed directly on the outer peripheral surface of base (1), and a thermally sprayed coating layer (2b) (a porous coating layer) having good machinability and heat insulating property and formed by mixing and thermally spraying a cermet powder and a resin powder on said heat-resistant thermally sprayed alloy layer (2a).

[0010]

As shown in Figure 1, the present invention adopts a two-layer thermally sprayed coating structure. First, Co-Ni-Cr-Al-Y type heat resistant thermally sprayed alloy layer (2a), which has high resistance against thermal impact and can effectively follow thermal expansion and compression, is formed as a foundation layer on the surface (roughened surface) of base (1) that constitutes the main body of the roll. Then, cermet/resin mixture thermally sprayed coating layer (2b) with good machinability and heat insulating property is laminated on said thermally sprayed coating (2a). By adopting this thermally sprayed coating structure, the heat resistance, machinability, and build-up resistance of the roll can be improved, and an excellent heat insulating property can also be realized.

[0011]

For the thermally sprayed coating layer (2b) formed by thermally spraying a mixture of cermet powder and resin powder, the content of the resin powder should be in the range of 15-30 wt% for the following reason. If the content of the resin powder is 15 wt% or more, a certain degree of abrasion resistance (machinability) can be guaranteed, and a thermally sprayed layer with a good heat insulating property can be obtained. In this way, deformation of the core of the roll can be prevented. On the other hand, if the content of the resin power is extended above 30 wt%, better effects cannot be expected. That is, even if the content of the resin powder is increased, the heat conductivity of the coating layer barely changes because the resin (examples of resins that can be used include nylon, polyester, polypropylene, etc.) is present at locations where air holes would be formed. On the other hand, the abrasion ratio increases significantly as a result of the drop in the bonding force between the coating layers. In particular,

when the content of the resin powder is more than 40%, the coating layer can peel off. Consequently, the best content of the resin powder is in the range of 15-30%.

[0012]

Figure 2 shows the results of investigating the influence of the resin powder on the heat conductivity and abrasion ratio of the roll in the case when a roll having a thermally sprayed coating layer made of 100% of cermet is used as the base. As can be seen from this figure, when the content of the resin powder is in the range of 15-30 wt%, that is, when the content of the cermet powder is in the range of 70-85 wt%, both the heat conductivity and abrasion ratio are low.

[0013]

The manufacturing of said heat-resistant thermally sprayed alloy layer (2a) is not limited to Co-Ni-Cr-Al-Y alloys. For example, Ni-Cr-Al-Y alloys, Co-Cr-Al-Y alloys, etc. can also be used in the present invention.

[0014]

In order to form a thermally sprayed film with excellent machinability, the cermet powder used as the thermal spraying material is preferred to be a mixture containing 4-10 wt% BN and at least one metal selected from Ni, Co, Cr, Fe, and Al or their alloys as the remainder.

[0015]

It is preferable to use a gas combustion method to form the thermally sprayed coating layer of the mixture of the cermet powder and the resin powder.

[0016]

When forming said heat-resistant thermally sprayed alloy layer (2a) on the surface of base (1), in order to increase the compactness of the layer which depends on the anchoring effectiveness of the thermally sprayed film, it is preferable to carry out a plasma treatment in advance on the surface of base (1) to roughen the surface (Rad: about 2-4 μm). Also, it is preferable to polish the surface of the thermally sprayed coating layer so that the surface roughness becomes Ra: 10 μm or lower. As far as the thickness of the thermally sprayed coating layer is concerned, the thickness of the foundation layer is preferably 200 μm, while the thickness of the thermally sprayed coating layer made of the powder mixture of cermet powder and resin powder is preferably about 1.0 mm.

[0017]

Application examples

The transporting roll shown in Figure 1 was arranged in a stainless steel plate heat treatment furnace with a capacity of 30,000 ton/month. The use status of the roll was investigated. The results are listed in Table 1.

Table 1

	No	母材 ①	被覆材料 ②	厚さ (mm) ③	処理量 (t) ④	交換理由 ⑤
⑥ 比較例	1	SCH12	⑦ アスベスト	20	6000	アスベストの脱落 ⑩
	2		⑧ シリカ・アルミ繊維	20	6000	ビルドアップの発生 ⑪
	3		⑨ サーメット粉末	1.0	12000	回転不良による擦り傷発生 ⑫
⑦ 適合例	4	SCH12	⑭ サーメット粉末 +樹脂粉末 (16%)	1.0	26000	⑫ 回転不良による擦り傷発生
	5		⑮ サーメット粉末 +樹脂粉末 (20%)	1.0	42000	摩耗 ⑱
	6		⑯ サーメット粉末 +樹脂粉末 (25%)	1.0	20000	摩耗 ⑱
	7		⑰ サーメット粉末 +樹脂粉末 (28%)	1.0	15000	剥離 ⑲

Key:

1	Base material
2	Coating material
3	Thickness
4	Processing amount
5	Reason for replacement
6	Comparative Example
7	Asbestos
8	Silica/alumina fiber
9	Cermet powder
10	Fall-off of asbestos
11	Occurrence of build-up
12	Occurrence of scratches caused by poor rotation
13	Application example
14	Cermet powder + resin powder (16%)
15	Cermet powder + resin powder (20%)
16	Cermet powder + resin powder (25%)

17 Cermet powder + resin powder (28%)
18 Abrasion
19 Peel off

[0018]

For conventional rolls using asbestos or silica/alumina fiber as the coating material, when the production amount reaches 6000 ton, the coating material falls off, or build-up occurs. Therefore, it is necessary to replace the roll in order to prevent deterioration (flaws) in the quality of the stainless steel plate. On the other hand, when a thermally sprayed coated roll made of 100% cermet powder is used, when the production amount reaches 12,000 ton, poor rotation occurs because the core is bent. Therefore, it is necessary to replace the roll in order to prevent deterioration (occurrence of scratches) in the quality of the stainless steel plate.

[0019]

On the other hand, for a roll having a thermally sprayed coating layer formed by adding 16% resin powder in cermet powder, although poor rotation finally occurs due to deformation of the core, the roll can be used until the product amount is increased by about 2.2 times. The roll with a resin powder content of 20% can be used with no bending in the core until the production amount reaches 42,000 ton (abrasion limit). For a roll having a thermally sprayed coating layer with the resin powder content higher than the level specified in the present invention, however, the thermally sprayed coating layer is worn off more quickly. Especially at a mixing percentage of 28%, the coating layer peels off when the production reaches 15,000 ton. As a result, the roll must be replaced.

[0020]

It has been confirmed that the service life of a roll can be prolonged significantly when resin powder is mixed with cermet powder in an amount of 15-30%.

[0021]

Effect of the invention

As explained above, according to the present invention, since a high heat insulating property can be realized even at relatively high temperature, poor rotation caused by bending of the core of the roll can be avoided. Also, since the roll has good machinability, no build-up will occur, and the service life of the roll can be prolonged. In addition, since the service life of the roll is extended, the maintenance period can also be prolonged, and the operation efficiency of the equipment can be improved.

Brief description of the figures

Figure 1 is a diagram explaining the configuration of the transporting roll disclosed in the present invention.

Figure 2 is a diagram illustrating the relationship between the amount of cermet and resin in the powder mixture and the heat conductivity.

Explanation of symbols

1	Base
2	Thermally sprayed coating layer
2a	Heat-resistant thermally sprayed alloy layer
2b	Thermally sprayed coating layer

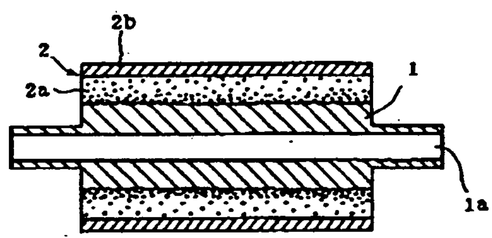


Figure 1

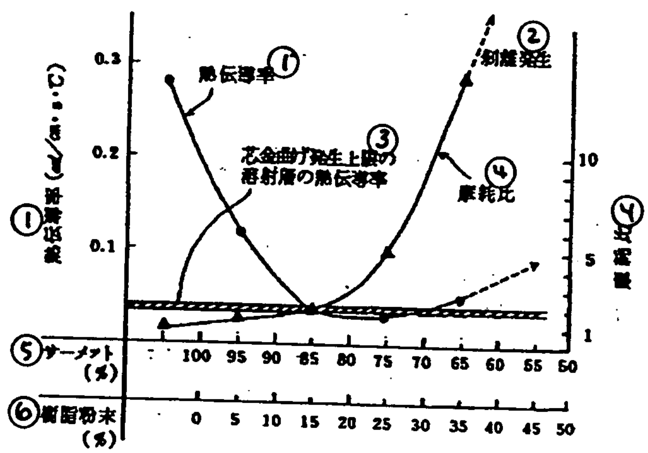


Figure 2

Key: 1 Heat conductivity
2 Occurrence of peel-off

3 Heat conductivity of the thermally sprayed layer at the upper limit where the core will bend
4 Abrasion ratio
5 Cermet
6 Resin powder

Japanese Kokai Patent Application No. Sho 63[1988]-203098

Job No.: 598-84875 Ref: 3600.1622-D1
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910 West Avenue, Austin, Texas 78701 USA

JAPANESE PATENT OFFICE
PATENT JOURNAL (A)
KOKAI PATENT APPLICATION NO. SHO 63[1988]-203098

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Filing Date:	February 19, 1987
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Examination Request:	Not filed

MANUFACTURING METHOD OF DIAPHRAGM FOR SPEAKER

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Agents:	Muneharu Sasaki, patent attorney, and 2 others

[There are no amendments to this patent.]

Claims

1. A manufacturing method of a diaphragm for a speaker characterized by the fact that a thermal-spraying material is deposited on the back side of a projecting frame plate by means of

thermal spraying, and the frame plate is sintered at a high temperature to adhere the frame plate to the thermal-spraying material.

2. The diaphragm for the speaker described in Claim 1 characterized by the fact that the thermal-spraying material is a metal material.

3. The diaphragm for the speaker described in Claim 1 characterized by the fact that the thermal-spraying material is an alloy material.

4. The diaphragm for the speaker described in Claim 1 characterized by the fact that the thermal-spraying material is a ceramic material.

5. The diaphragm for the speaker described in Claim 1 characterized by the fact that the aforementioned frame plate infiltrates into the aforementioned thermal-spraying material as a result of said sintering for adhesion.

6. The diaphragm for the speaker described in Claim 1 characterized by the fact that the aforementioned frame plate is adhered as a compound to the aforementioned thermal-spraying material as a result of said sintering.

<u>Detailed explanation of the invention</u>

Industrial application field

The present invention pertains to a manufacturing method of a diaphragm for a speaker.

Prior art

A diaphragm for a speaker is required to be light and have a high rigidity as well as a certain degree of internal loss. A diaphragm for a speaker is usually manufactured by thermal spraying a metallic material on a frame plate, for example, by thermal spraying alumina on aluminum.

Figure 3 is a cross-sectional view illustrating a conventional diaphragm for a speaker obtained by thermal spraying a metallic material on a frame plate of the diaphragm for the speaker. In Figure 3, (1) represents a frame plate, (2) represents the thermal-spraying material deposited on the projecting surface of frame plate (1).

Frame plate (1), on which thermal-spraying material (2) is thermal sprayed, is a metallic press molding product made of aluminum, titanium, or other metallic material with excellent heat resistance and a relatively high sound velocity. Alumina, boron nitride, or other ceramic material with a higher E/ρ than the E/ρ of frame plate (1) is used as a thermal-spraying material (2).

Problems to be solved by the invention

However, the aforementioned conventional diaphragm for the speaker has bubbles inside because the parts are intertwined and bonded to each other where the fine particles of the ceramic material used as thermal-spraying material (2) are flatly sprayed. As a result, the sound velocity of the entire diaphragm for the speaker is much lower than that of the ceramic material. It is unable to obtain a high-performance diaphragm for the speaker.

The purpose of the present invention is to solve the aforementioned problem by providing a method for manufacturing a high-performance diaphragm for the speaker.

Means to solve the problems

The present invention provides a manufacturing method of a diaphragm for the speaker having a step in which a thermal-spraying material is deposited on the back side of a projecting frame plate by means of thermal spraying and a step in which the frame plate is sintered at a high temperature to adhere the frame plate to the thermal-spraying material.

Operation

For the diaphragm for the speaker manufactured by the aforementioned method of the present invention, the spaces formed as a result of thermal spraying are sintered. Therefore, the diaphragm has a compact state. The sound velocity of the diaphragm is also high.

Application example

In the following, an application example of the present invention will be explained with reference to the attached figures.

Figure 1 is a cross-sectional view illustrating a diaphragm for the speaker manufactured by the method of the present invention. In Figure 1, (3) represents a sintered thermal-spraying material, and (4) represents a frame plate that infiltrates into the thermal-spraying material.

In the following, the manufacturing method of a diaphragm for the speaker disclosed in the present invention will be explained. First, as shown in Figure 2, an aluminum material is molded by means of drawing it into a dome-shaped frame plate (1). Then, boron carbide is deposited by means of plasma thermal spraying as thermal-spraying material (2) on the back side of frame plate (1), that is from the concave side. After that, frame plate (1) is sintered at 1800-2000°C in a vacuum atmosphere. As a result, frame plate (1), the aluminum material, is deposited in the form of aluminum oxide on the boron carbide. In some cases, frame plate (4) forms a hot compound together with thermal-spraying material (2). As a result, the diaphragm for the speaker shown in Figure 1 is obtained. Since boron carbide is not decomposed even at

1800-2000°C, the spaces caused by thermal spraying are sintered, and a diaphragm with a very compact state can be obtained for the speaker.

The E/ρ value of the diaphragm obtained after the boron carbide is thermal sprayed onto the aluminum material becomes as high as 1.5×10^{12} dyne/cm^2, which is about 2.75 times of 0.6×10^{12} dyne/cm^2.

In the present application example, an aluminum material is used for the frame plate. However, the same effect as that of the present application example can be realized by using titanium or another metal, resin material, or any material that can be molded into a dome shape and has no significant deformation under the thermal spraying heat.

It is also possible to use alumina, silicon carbide, or another material that can be applied by means of thermal spraying and has a higher E/ρ value and a higher melting temperature than the frame plate as the thermal-spraying material.

Effect of the invention

As explained above, according to the present invention, a thermal-spraying material is first deposited on the back side of a projecting frame plate by means of thermal spraying. Then, the frame plate is sintered at a high temperature to adhere the frame plate to the thermal-spraying material. Consequently, the present invention provides a method which can manufacture a diaphragm for the speaker with a high E/ρ value, that is, a high sound velocity.

Brief description of the figures

Figure 1 is a cross-sectional view illustrating a diaphragm for the speaker manufactured with the method disclosed in the present invention. Figure 2 is a diagram explaining the method disclosed in the present invention for manufacturing the diaphragm for the speaker. Figure 3 is a cross-sectional view illustrating a conventional diaphragm for the speaker.

In the figures, (1) represents a frame plate, (2) represents a thermal-spraying material, (3) represents the thermal-spraying material after sintering, and (4) represents the frame plate after sintering.

The same symbols in the figures represent the same or corresponding parts, respectively.

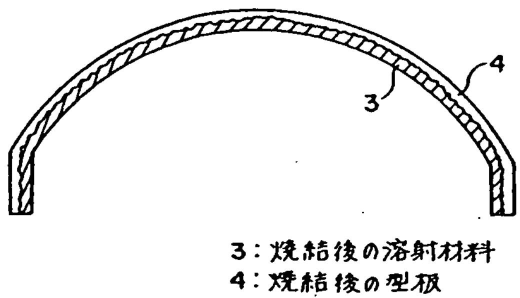

Figure 1

Key: 3 Thermal-spraying material after sintering
4 Frame plate after sintering

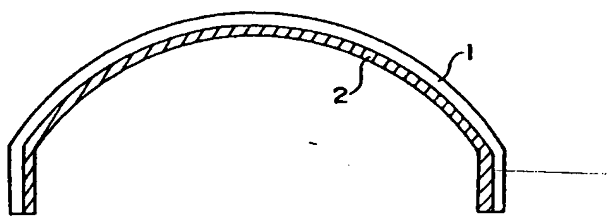

Figure 2

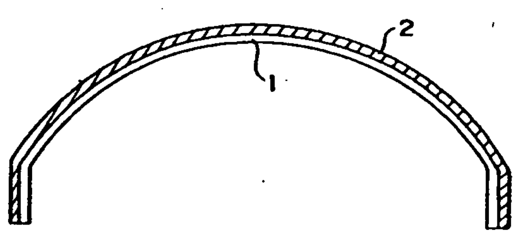

Figure 3